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Study of a possible relationship between pure tone hearing acuity and verbal and performance WISC score differences found in children in educable mentally retarded classrooms in Montana

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The University of Montana

A STUDY OF A POSSIBLE RELATIONSHIP BETWEEN PURE TONE HEARING ACUITY AND VERBAL AND PERFORMANCE WISC SCORE DIFFERENCES FOUND IN CHILDREN IN EDUCABLE MENTALLY RETARDED CLASSROOMS IN MONTANA

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CHAPTER I

INTRODUCTION

Mental retardation ranks nationally as a major health, social and economic problem. There are five and one half million mentally retarded people--almost three percent of the population--in this country today. Mental retardation disables ten times as many people as diabetes, twenty times as many as tuberculosis, twenty-five times as many as muscular dystrophy and six hundred times as many as polio. The incidence of mental retardation is exceeded only by mental illness, heart disease, arthritis and cancer. Between fifteen and twenty-five million Americans live in families in which there is a mentally retarded person. (President's Panel on Mental Retardation, 1963, pp. 8-13)

Mental retardation has no single cause. Improper prenatal care, birth injury, heredity, and a host of unknown conditions can cause faulty or arrested mental development to the extent that the stricken person cannot cope with the demands of society. But with early detection and suitable training, the mentally retarded can often attain significant improvement in social ability, personal adjustment and achievement.

The President's Panel on Mental Retardation defines mental retardation as "a condition characterized by a faulty development of intelligence, which impairs an individual's ability to learn and to adapt to the demands of society." (p. 8)

Psychological testing is one method used to assess the intellectual development of a child or adolescent in comparison to others in his age group. The Wechsler Intelligence Scale for Children is such a test. "In many respects the WISC standardization sample of 2200 cases from 5-15 years of age is more representative of the country at large than any other samples employed in standardized testing. (Anastasi, pp. 316). The results obtained from testing these 2200 children were averaged in percentiles with the middle fifty percent of children at each age receiving a numerical score from 90-110 which was in turn called his intelligence quotient or IQ.

"At the most objective level the Wechsler scales yield an IQ with high reliability and fair evidence of validity." (Anastasi, pg. 135).

This middle percent group of children was judged as developing at the rate that might be expected of a child his age. His intelligence quotient was classified as within normal range. Children falling in the twenty-five percent below the middle range were classified as the following: 1) borderline slow learner with an IQ range from 75-89, 2) educable mentally retarded or those who develop at a reduced rate and whose IQ scores range from 50-74, 3) trainable mentally retarded with an IQ between 25 and 49, and, 4) those with an IQ below 25 or totally dependent individuals. (Wechsler, pg.4)

In Montana, special classroom facilities are provided for children who because of mental retardation, emotional problems and or learning disabilities can not maximally profit from an educational program in the regular classroom. Such a facility is called an educable mentally retarded classroom. By definition only those children with intelligence scores below 75 should participate in such a class, but in Montana special classrooms are not provided for the slow learner. These children frequently learn at a rate that is consistent with mentally retarded children. Therefore, because of educational need and inappropriateness of the normal classroom, these children are best housed in an educable mentally retarded classroom environment. Consequently children with IQ's from 50-90 are placed in the same classroom. Usually the classrooms contain not more than fifteen children whose chronological ages are within five years of each other. (State of Montana, <u>Special Education Handbook</u>, May, 1967, F837-411.300-5/67, pp. 1-2). Henceforth, for the purpose of this paper, the term mentally retarded operationally refers to children in educable mentally retarded classrooms regardless of IQ.

The WISC contains twelve tests which are divided into two subgroups, identified as Verbal and Performance. The Verbal and Performance Scores have been found to be quite accurate and the differences between them have an estimated reliability of .74. "This is high enough to justify drawing conclusions about the person whose Verbal and Performance IQ's differ by fifteen or more points." (Cronbach, pg. 198). Therefore, according to Cronbach, who bases his conclusion on a study done by McNemar, a difference of fifteen points between the Verbal and Performance Score is considered statistically significant and requires explanation. (Cronbach, pg.198)

According to Anastasi, (pg. 323) when a person does much better on the Performance than on the Verbal tests, one might suspect the person of having a language handicap. A hearing loss is considered a handicap influencing the learning of a language. (Davis and Silverman, pg. 461). To illustrate, "one who suffers from deafness will perform badly on tests of word knowledge and verbal reasoning both because of limited ability to reason verbally." (Cronbach, pg. 199). Word knowledge and verbal reasoning are measured by Verbal subtests on the WISC. Other studies also cite the possibility that hearing loss may influence understanding and comprehension on an IQ test, particularly the verbal portions. (Schlanger, pg. 24; Rittmanic, pg. 780) Pantomime and imitation can be employed to help one understand and comprehend instruction on the Performance section of an IQ test whereas, the Verbal subtests instruction require the utilization and integration of auditory information. Therefore, a mentally retarded child's comprehension of instruction on Verbal subtests of the WISC might be impeded by a hearing loss. Thus, the Verbal score received on such a test quite possibly may be depressed and not a valid measure of ability. The Verbal and Performance Score make up the Full Scale Score, which is one's IQ measurement. An individual, primarily for educational purposes, is categorized as normal, above normal, or retarded on the basis of an IQ score received on an intelligence test.

According to Fisch (pg. 132) it is important not only to differentiate between mental retardation and hearing loss but also to correctly assess the degree of both. A consensus of studies compiled by Kodman (pg. 676) using pure tone audiometric testing with mentally retarded children indicates that approximately twenty percent of mentally retarded children as compared to five percent of normal school age children (Davis and Silverman, pg. 416) evidence a medically significant hearing loss. The American Academy of Otolaryngology and Opthalmology recommends that losses in excess of 25 dB ISO for two or more frequencies in one or both ears are medically significant and sufficient reason for medical referral.

Educable mentally retarded classroom children were chosen for this study because: 1) Performance, Verbal and Full Scale Score WISC results were available on these children. In Montana, a child is admitted to a special education class on the basis of an intelligence score. 2) Apparently mentally retarded children evidence a higher incidence of hearing loss. 3) A hearing loss can effect particularly the Verbal score results of the WISC. 4) After inspection of the WISC score results, it was apparent that a number of children in educable mentally retarded classrooms evidenced a depressed Verbal score of at least 15 points. and 5) These children tend to adapt more readily to amplification and/or auditory training than children who are more severely retarded. (Fisch, pg. 130; Schlanger, pg. 24)

Could then, an undetected hearing loss be one explanation as to the cause of a significant depression of Verbal score below Performance score?

Statement of the Problem

Thus far it has been established that: 1) mentally retarded children evidence a higher incidence of hearing loss than normal children and 2) a hearing loss may effect results more on the Verbal scale than the Performance scale of an IQ test such as the WISC. It therefore seems reasonable to assume that an undetected hearing loss may be a contributing factor in causing a discrepancy between the Verbal and Performance scores of the WISC if the depressed scale is the Verbal one.

Hypothesis

It is hypothesized that as a group children from educable mentally retarded classrooms who have significantly higher Performance than Verbal scores on the WISC will have a higher incidence of hearing loss than a comparable group of children from educable mentally retarded classrooms who have no significant disparity between Verbal and Performance scores on the WISC and whose Full Scale Scores do not differ significantly from the experimental groups.

CHAPTER II

PROCEDURE

Purpose:

The purpose of this study was to determine the relationship between hearing loss and WISC scores of two groups of children attending educable mentally retarded classrooms in public school systems in Montana.

Subjects:

Subjects for this study were selected from a list of special education children in Montana provided by the State Director of Special Education. The list also contained each child's Verbal, Performance and Full Scale Score WISC results. Since it was deemed necessary to test each subject's hearing in as ideal acoustic environment as possible, only children from Billings, Great Falls and Missoula were selected as subjects. Each of these cities has an acoustically isolated testing room. The Billings Public School System elected not to allow their pupils to take part in this study, therefore, only children in special education classes in Great Falls and Missoula were used as subjects.

Permission to conduct this study using the above children was requested from respective superintendents of schools. Parents of the children selected for this study received a letter from the director of special education requesting permission for their child to participate in this study. The subjects were transported to a hearing testing room either by parents or the director of special education of the school system.

In an attempt to help the experimenter avoid experimenter bias, the respective directors of special education agreed to take the birthdates, Verbal, Performance and Full Scale Scores on the WISC for the subjects selected for Group I, the experimental group. Each Group I subject was matched with a special education child whose Full Scale Score did not differ more than 2 SE_m (8 points) from their Full Scale Score. The directors tried to match the subjects according to sex and age within three years. (Appendix A,B). After testing was completed, the experimenter categorized the subjects according to experimental and control groups and analyzed the results.

Group I was composed of twenty-six children from mentally retarded classes whose Verbal scores on the WISC were at least fifteen points below their Performance scores. A difference of fifteen points between the Verbal and Performance score is considered significant and requires explanation. (Cronbach, pg. 198). Mean difference between Verbal and Performance score was 23 points. Group II, the control group, was composed of twenty-six children from educable mentally retarded classrooms whose Verbal and Performance scores did not differ significantly. Mean difference between the scores was 5.5 points. Every effort was made to match the Full Scale Scores of a Group I subject as closely as possible to a Group II subject's Full Scale Score, as it is primarily on this basis that a child is placed in a special classroom. At no time did the differences between Full Scale Scores between the two groups exceed $2SE_m$. (Wechsler, pg.13).

The difference between the Full Scale Scores between the two groups was 3.6 points. This is less than $1SE_m$. (Wechsler, pg. 13)

The subjects were transported from their individual schools to testing facilities at either the University of Montana, Missoula or the Easter Seal Rehabilitation Center, Great Falls. To reduce transportation problems, all of the subjects were placed in groups according to school locality. Two sessions of testing were held daily, one in the morning and one in the afternoon. One to six children were tested during each session. Playroom facilities were provided for the children while they were waiting to be tested. To help minimize fatigue and attention problems, each subject returned to the playroom after being tested by the experimenter.

Testing:

Testing was done in an audiometric testing room using either a portable Beltone 10-D or Maico 2B audiometer. A Bruel and Kjaer artifical ear type, 4152, precision sound level meter type, 2203 and equipment were used to check the calibration of each audiometer immediately before and after testing. In all cases the audiometers were found to be calibrated within the tolerance level standards at all frequencies. (Hirsh, pg. 306) The hearing tests were administered in a hearing testing room. By being present in the same room as the subjects, the examiner hoped to minimize distraction tendencies of the subjects which would influence concentration on a hearing test.

According to Fisch (pg. 124),

> "The fundamental difficulty in assessing the ability to hear is created by the fact that we do not possess reliable objective hearing tests, based on involuntary and consistant

> physiological reaction to sound stimulation, which could be applied as routine regardless of mental ability or age of the child. Existing practical methods are subjective tests. In these, one has to rely on observation of responses to sound stimulation."

Therefore, the audiological procedure consisted of the administration of a pure tone air conduction test using an approved clinical technique. (Hirsh, pg. 112-114, 263-75, 283-86: Carhart, pg. 331) One modification in the above technique was made. Kodman (pg 304b) found a puretone descending series technique to give reliable results in testing the hearing of mentally retarded children. Therefore, instead of using an ascending-descending technique a descending technique was employed.

According to Hirsh (pg. 262) "...we tend to define hearing in terms of a raised finger or a pressed signal button after we have verbally instructed the listener to respond in that way." For the purpose of this examination, each subject was given the following instructions!

> "Hi, today I would like you to play a pilot game" with me and you can be the pilot. An airplane pilot always wears earphones like these, (show subject the earphones). Through the earphones a pilot hears sounds. Let's see if we put the earphones over our ears if we can hear some sounds. I'll be first. If I hear a sound, I'll raise my hand to let you know that I have heard it." (The examiner then places the headset over her ears and raises her hand as a response to hearing the tone so that the subject can see the hand response. The examiner will then say), "I heard the sound so I raised by hand. Now you can play pilot and see if you hear the sounds. Remember to raise your hand if you hear even the softest sound." A 50 dB tone is administered.

If a correct response was given, the subject was rewarded by a smile or a verbal, "that's good" from the examiner. The subject was considered ready for threshold testing when he responded by raising his hand consecutively three times to a 50 dB tone.

After the subject had been conditioned, the first tone presented was 1000Hz at 50 dB. Intensity was lowered in five decibel steps until a threshold had been reached. Threshold was determined by presenting a tone until the hearing level results for each frequency were consistent two out of three times on each test. The frequencies of 500, 1000, 2000 and 4000 were tested. If an air conduction loss of 15dB or greater was evinced at any frequency, bone conduction testing was employed. Masking was utilized during air conduction testing when the 40 dB intra-aural attentuation could not be ruled out in the contra-lateral participation. (Glorig, pg. 117) During bone conduction testing masking was used when the 15 dB intra-aural attenuation could not be counted on to rule out contra-lateral participation. (Glorig, pg. 123) Each subject was given two consecutive pure tone tests by the examiner. This was done with the hope of obtaining a reliable threshold measure. These tests were administered first and the results were used as a test for intra-tester reliability.

Reliability of threshold was further checked by having another audiologist administer a pure tone test to each of the subjects. Independently using the same techniques as the experimenter, this person obtained threshold tests for each of the subjects. Thus, all subjects received at least three hearing tests.

Cohen's correlation analysis (pg. 37-49) was performed on the audiological results, the second test of the experimenter and the test of the independent audiologist, as a check for intertester reliability. (Appendix C, D)

Analysis of Data

At the conclusion of the study the mean hearing loss for the right and left ears and the mean loss for both ears was computed for each group. The difference between means was tested by a "t" test. Chi square contingency tables were used to measure significance between the experimental and control groups using a criteria of 15 dB hearing loss or more between right ears, left ears and combined right and left ear losses.

CHAPTER III

RESULTS

Using approved clinical techniques, individual pure tone threshhold tests were administered to fifty-two children in educable mentally retarded classes between the ages of five and seventeen. Of the fifty-two children, nineteen were female and thirty-three male.

After the experimenter had finished her testing, all of the subjects were felt to be conditioned to the pure tone technique used. This is verified by the results of the inter-tester reliability check. In each case, an independent audiologist administered a comparable pure tone threshold test. Using Cohen's correlation variance, a reliability coefficient of .96 was obtained. It seems reasonable to assume that the data of this study are derived from reliable assessment of these individual's pure tone audiograms. (Table I)

After tabulation of the data, an attempt was made to analyze the results by Chi square contingency tables. The three contingency tables proposed were: 1) comparison of experimental and control subjects' mean right ear hearing losses of more and less than 15 dB. 2) comparison of experimental and control subjects' mean left ear hearing losses for more and less than 15 dB, and 3) comparison of experimental and control subjects' combined right and left ear mean hearing losses of more and less than 15 dB.

TABLE I

COHEN'S COEFFICENT OF AGREEMENT
RESULTS BETWEEN EXAMINERS

$$\begin{array}{rl} & 398 \text{ agreements} \\ + & \underline{18} \text{ disagreements} \\ & 416 \end{array}$$

$$416 \overline{\smash{)}398.00}^{\;.956}$$

.96 coefficient of agreement
between examiners

From visual inspection of the first two contingency tables (Table II), it is obvious that there is no significant difference between right ear or left ear losses between the experimental and control groups. Analyzing the combined right and left ear losses between the two groups yielded a x^2 of 2.93 which is not significant at the .05% level of confidence.

Results of the "t" tests between right ear, left ears or combined mean hearing losses between the two groups were not significant at the 5 % level of confidence. (Table III).

There is then no evidence for accepting the hypothesis that children in educable mentally retarded classes who have been given the WISC intelligence test and who have significant depression (15 points) in Verbal scores have significantly greater hearing loss than educable mentally retarded individuals who do not evidence this discrepancy between Verbal and Performance scores.

TABLE II

CHI SQUARE TABLES FOR RIGHT, LEFT, AND
COMBINED (RIGHT PLUS LEFT) HEARING LOSSES
FOR THE EXPERIMENTAL AND CONTROL GROUPS

Right Ear Obtained Frequency			
	Mean loss 15 dB	Mean loss 15 dB	N
Experimental Group	22	4	26
Control Group	22	4	26

Left Ear Obtained Frequency			
	Mean loss 15 dB	Mean loss 15 dB	N
Experimental Group	22	4	26
Control Group	22	4	26

Combined (right plus left) Ears Obtained Frequency			
	Mean loss 15 dB	Mean loss 15 dB	N
Experimental Group	13	13	26
Control Group	7	19	26

*a x^2 of 3.84 (df = 1) is required
for significance at the 5% level

TABLE III

Mean Hearing Losses and "t" Scores of the Experimental and Control Groups

Ear	Subjects	Mean	"t"
right	experimental	167.75	.443*
	control	195	
left	experimental	146.25	.625*
	control	171.25	
combined	experimental	151.69	.787*
right plus left	control	210.21	

*a "t" value ot 2.06 (df = 25) is required for significance at the 5% level

CHAPTER IV

DISCUSSION

From reports in the literature it appeared that: 1) mentally retarded children do evidence at least a two to three times greater hearing loss than normal children and 2) conventional pure tone audiometric testing seemed to be a reliable method for testing hearing acuity in school age mentally retarded children.

Using methods that measure auditory peripheral function (pure tone audiometry), this author did not find evidence to support the hypothesis that as a group children from educable mentally retarded classes who have significantly higher Performance scores on the WISC have a higher incidence of hearing loss than a comparable group of children from educable mentally retarded classrooms who have no significant disparity between Verbal and Performance scores on the WISC and whose Full Scale Scores do not differ significantly from the experimental group. It is not felt that different matching or number of subjects would have influenced the significance of the results more than the present design did.

From results evidenced in this study, peripheral hearing loss does not seem to be one of the major contributing factors causing the discrepancy between Verbal and Performance scores on the WISC. However, before one can exclude the possibility it would be adviseable to consider some findings reported in recent literature. For example, the sophistication of peripheral auditory testing as it might apply to this study.

According to Bocca and Calearo, (Jerger, pg. 350), it is possible for a person or group of persons with hearing within normal limits or with a peripheral loss to have an auditory

> " responses to tonal messages involving elementary motor responses do not require the activation of the language centers by speech material (containing complex sound stimuli) is a guarantee that the message has arrived, as such, at the cortex, thus testing all stages of integration as far as the higher level."

There are tests in the experimental stages which are designed to measure one's auditory integrative and cognitive ability. Integrative being the ability to recognize and respond to complex sound stimuli. Integrative testing using complex sound stimuli of meaningful and/or meaningless words or sentences presumably measure this auditory function at the neuronal, cortical or subcortical level. This conventional pure tone testing does not do. For example, Bocca and Calearo (Jerger, pg. 345) propose two types of tests that use messages with a complex integrated structure such as to evoke the particular type of activity that is characteristic of auditory processes at these levels. These tests are the monaural and binaural speech integration tests. The monaural speech tests, with distorted meaningful and meaningless words or sentences sample integrative function of the neuronal tract at the cortical and subcortical level. (Jerger, pg.365)

Hearing at the cortical level requires summation and integration of language stimuli involving symbolization and memorization, i.e., the cognitive processes proper. The binaural speech tests are:

> "based on the principle of the central summation of the two parts of a monaural message, each of these two parts being insufficient for identification. It is therefore, more appropriate to refer to them as summation tests rather than integrative tests."
> Bocca and Calearo (Jerger, pg. 365)

Presumably it is this author's interpretation that the latter test attempts to measure the summation and/or cognitive function of the auditory system.

An intelligence test such as the WISC requires that one have the ability to perceive, discriminate and integrate such auditory function. Therefore, one's integrative and cognitive ability may influence how one performs on Verbal subtests. The information transmitted to be understood and integrated on a monaural or binaural speech integration test is not as complex as the information relayed on a psychological test. A possible auditory disability as indicated by the results of one of the speech integrative tests could effect any task on a psychological test calling for more complex integrative and cognitive functioning.

If, according to Bocca and Calearo (Jerger, pg. 344) pure tone testing does not measure one's auditory integrative and/or cognitive ability one then might theorize that subjects used in this study might have undetected integrative or cognitive losses. These losses might account for the depression in Verbal score evidenced by experimental subjects in this investigation.

The above tests are in the research stage and not yet standardized. However, from the results reported by Bocca, Clearo, Goldstein and Lafon (Jerger, pg. 365) there seem to be ample opportunity for future investigation into this method of measuring integrative and cognitive function. To this author's knowledge, testing integrative and cognitive function by either the monaural or binaural speech integration tests has not been attempted with children in educable mentally retarded classrooms.

Before such tests could be employed it would be necessary to ascertain whether the mentally retarded child has the ability to understand and respond to this specific method of testing. If not, perhaps future research will yield a modified form of the monaural or binaural speech integration tests that can be used to measure the integrative functioning that elementary tonal testing can not do.

While it was not a primary purpose of this study, it might be useful to report findings in this investigation which concur with the literature's report on the incidence of hearing loss in mentally retarded children.

Reports of studies in which mentally retarded children were tested give incidences of hearing loss ranging from thirteen to fourty-nine percent (Table IV). These results are only roughly comparable because the frequencies tested varied, the ages and IQ's of the groups differed, and the criteria for "significant hearing loss" were dissimilar. The above studies found from two and one half to ten times as many hearing impairments among the retarded as among the normal school population, in which an estimated five percent have auditory losses. (Rittmanic, pg. 779)

Approximately twenty percent of the children in educable mentally retarded classrooms used as subjects in this investigation evidenced a medically significant hearing loss. (Table V) This is positive support of a reported greater incidence of hearing loss in mentally retarded children. To illustrate, the design of this study closely resembles an investigation done by Rittmanic (pg. 780). Rittmanic used pure tone audiometry as a means of determining incidence of hearing loss in mentally retarded children. The criterion used for

TABLE IV

COMPARISON OF HEARING LOSS DATA IN MENTALLY RETARDED CHILDREN*

Investigations	N	Hearing Loss Criterion*	Incidence of Loss
Birch & Matthews (1951)	247	Ciocco & Palmer categories. Functional class B & C	33%
Schlanger (1953)	74	Binaural speech loss A.M.A. 4-10% or greater	30%
Foale and Patterson (1954)	100	Same as Birch	13%
Johnson & Farrell (1954)	270	30 dB or greater at two or more frequencies in either ear	24%
Bradley, et. al. (1955)	56	Same as Johnson and Farrell	32%
Schlanger & Gottsleben (1956)	188	Modified A.M.A. loss criterion	49%
Kodman, et. al (1956)	84	40 dB loss or greater at one or more frequencies in either ear	19%
Rittmanic (1959)	332	A.A.O.O., 25 dB loss in either ear at two or more frequencies	20%

*Kodman, Frank. "The Incidence of Hearing Loss in Mentally Retarded Children," American Journal of Mental Deficiency, 62, 1958 pp. 675-678.

* ISO standards

TABLE V

AIR & BONE CONDUCTION TESTING RESULTS
FOR SUBJECTS EVINCING A "MEDICALLY
SIGNIFICANT" HEARING LOSS*

	Right Ear					Left Ear				
Subject	.5K	1K	2K	4K	Bone	.5K	1K	2K	4K	Bone
4c	45	50	45	30	N	10	0	10	15	N
13c	0	0	0	65	SN	0	0	0	35	SN
15c	20	5	25	10	N	20	0	5	25	N
17c	0	0	45	35	N	0	5	0	5	N
23e	25	25	0	0	N	10	15	0	0	N
20c	0	0	35	20	SN	5	0	25	20	SN
25e	50	45	20	35	N	35	35	20	20	N
13e	30	10	25	25	N	30	20	10	25	N
8e	25	20	15	15	N	20	20	20	30	N
22e	35	30	10	10	N	25	25	0	15	N

Key *

c--control
e--experimental
N--normal, < 15 dB at any frequency
SN--sensory neural

defining a medically significant hearing loss was one recommended by the American Academy of Otolaryngology and Opthalmology. The Academy recommends that losses in excess of 25 dB ISO for two or more frequencies in one or both ears to be considered of medical significance and sufficient reasons for medical referral. Using this criterion for "medically significant hearing loss" both Rittmanic's study and this one revealed approximately twenty percent of the children tested between the ages of six and nineteen evidenced a "medically significant hearing loss".

Using air and bone conduction testing ten "medically significant" losses were found in this investigation. Of the ten, five were bilateral conductive losses and two were bilateral sensory neural losses. Often conductive losses can be remediated by medical attention. With the hope that adequate medical treatment would be instigated, a copy of each subject's audiogram with recommendations was sent to the respective directors of special education for follow-up.

CHAPTER V

SUMMARY AND CONCLUSIONS

Fifty-two educable mentally retarded children between the ages of five and seventeen were given pure tone threshold tests. Bone conduction testing was employed to help determine type of loss. When deemed necessary, masking was used.

Educable mentally retarded children who displayed significantly higher Performance than Verbal Scores did not evidence a higher incidence of pure tone hearing loss than a comparable group of educable mentally retarded children who evidenced no significant disparity between Verbal and Performance scores on the WISC and whose Full Scale Scores did not differ significantly from the experimental groups.

Limitations of this study were discussed and possible further areas of research expanded, i.e., use of the monaural and binaural speech integration tests. These tests employ the use of complex sound stimuli to measure integrative and cognitive auditory function. A peripheral (pure tone) hearing test does not do this. Perhaps in the future if tests of this nature could be adapted for use on children in mentally retarded classes, one might find a significant difference between integrative hearing levels of the two groups.

Ten, approximately twenty percent, of the fifty-two subjects tested evidenced a "medically significant" pure tone hearing loss. These results lend support to the literature which reports, at least a twenty percent hearing loss among the mentally retarded population. Using Cohen's correlation variance technique, a reliability coefficient of .96 was obtained between examiners.

In conclusion, a correlation between peripheral hearing loss and depressed Verbal score was not found. However, this author tends to concur with reports in recent literature that question the use of only peripheral testing as a measure of one's auditory acuity. Perhaps more sophisticated audiometric testing should be done before one rules out the possibility of hearing loss in educable mentally retarded classroom children and its effect on psychological testing. It seems plausible that an individual with a hearing disability might have difficulty integrating a verbal message and this in turn might influence his Verbal score. This author is in no way implying that hearing tests measure the same abilities as psychological tests. The information to be understood and integrated on a monaural or binaural speech integration test is not as complex in nature as the information on a Verbal section of a psychological test. Therefore, if a disability was discovered on the speech integration tests it would certainly be valuable information to relay to the psychologist doing the psychological testing.

A peripheral auditory test does not measure one's auditory integrative and cognitive ability. Therefore, before one can eliminate the possibility of hearing significantly influencing Verbal score, this type of testing should be done.

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APPENDICES

APPENDIX A

Wechsler Intelligence Scale Results of the Experimental & Control Groups

WISC RESULTS

V--Verbal Score
P--Performance Score
FSS--Full Scale Score

V-P--Verbal Score minus Performance Score
FSS_e-FSS_c-- Full Scale Score of experimental group minus Full Scale Score of control group

Experimental					Control					
Subject	V	P	FSS	P-V	Subject	V	P	FSS	P-V	FSS_e-FSS_c
1	63	80	69	17	1	71	76	71	5	2
2	67	93	77	26	2	89	90	85	1	8
3	45	69	53	24	3	60	65	59	5	6
4	67	83	72	16	4	80	80	78	0	6
5	70	92	77	22	5	76	90	81	14	4
6	65	107	82	42	6	79	85	79	6	3
7	67	103	83	36	7	86	83	83	3	0
8	67	94	78	27	8	75	80	75	5	3
9	62	86	71	24	9	79	82	78	3	7
10	70	103	84	33	10	80	79	76	1	8
11	69	86	75	17	11	70	82	73	12	2
12	82	103	91	21	12	82	95	87	13	4
13	67	96	79	29	13	82	89	84	7	5
14	67	89	75	22	14	84	83	82	1	7
15	70	87	76	17	15	75	85	77	10	1
16	67	85	73	18	16	75	75	72	0	1
17	63	86	72	23	17	73	77	73	4	1
18	66	90	75	24	18	69	73	69	4	6

Experimental					Control					
Subject	V	P	FSS	P-V	Subject	V	P	FSS	P-V	FSS_e-FSS_c
19	82	97=	88	15	19	82	89	84	7	4
20	69	90	77	21	20	80	78	78	2	1
21	67	83	72	16	21	72	81	74	9	2
22	72	87	77	15	22	73	77	73	4	4
23	63	80	69	17	23	63	69	63	6	6
24	70	100	82	30	24	79	85	80	6	2
25	85	101	92	16	25	87	80	84	7	8
26	67	89	75	22	26	76	80	76	4	1
				$\bar{X}$=23.2 points					$\bar{X}$=5.3 points	$\bar{X}$=3.6 points

APPENDIX B

Age & Sex of Experimental and Control Subjects

AGE & SEX OF EXPERIMENTAL AND CONTROL GROUPS

Experimental			Control		
Subject	Age	Sex	Subject	Age	Sex
1	10	M	1	10	M
2	9-6	F	2	11-4	M
3	15-4	F	3	19-6	M
4	9-7	F	4	9-11	M
5	10-7	M	5	12	M
6	17-8	F	6	15-6	M
7	11-5	M	7	9-10	F
8	11-3	F	8	11-2	M
9	13-1	M	9	12-1	M
10	9	M	10	10-7	M
11	15-2	M	11	14	M
12	14-7	M	12	17	F
13	15-4	M	13	15	M
14	13	F	14	12-6	F
15	9-1	M	15	10-3	M
16	5-8	F	16	8-5	F
17	16-6	M	17	17	M
18	15-7	M	18	17-6	F
19	14-3	M	19	16-10	M
20	14-11	M	20	17-4	M
21	14-9	F	21	16-4	F

Experimental			Control		
Subject	Age	Sex	Subject	Age	Sex
22	14-6	F	22	17-5	F
23	11-4	M	23	12-9	M
24	8-7	M	24	10-4	M
25	8-11	F	25	12-9	M
26	11-7	M	26	10-10	F

APPENDIX C

Pure Tone Air & Bone Conduction Test

Results for the Experimental Group

PURE TONE HEARING TEST RESULTS
FOR THE EXPERIMENTAL GROUP

	Right Ear					Left Ear					
Subject	.5K	1K	2K	4K	$\overline{X}$	.5K	1K	2K	4K	$\overline{X}$	R+L $\overline{X}$
1	0	0	0	0	0	0	0	5	0	1.25	.62
2	0	0	0	0	0	0	0	0	15	3.75	1.87
3	0	0	0	5	1.25	0	0	0	0	0	.62
4	0	0	0	5	1.25	0	0	0	0	0	.62
5	0	0	0	0	0	5	0	0	0	0	.62
6	0	0	0	10	2.5	0	0	0	10	2.5	2.5
7	0	0	5	0	1.25	5	10	0	0	3.75	2.5
8	25	20	15	15	18.75	10	10	20	30	17.5	20.6
9	0	0	0	5	1.25	0	0	0	5	1.25	1.25
10	0	0	0	10	2.5	15	10	0	10	8.75	5.62
11	5	0	0	0	1.25	0	0	0	5	1.25	1.25
12	0	0	0	0	0	0	0	5	15	5	2.5
13	30	10	25	25	22.5	20	10	10	25	16.3	19.3
14	10	10	0	0	5	10	0	10	5	6.3	5.6
15	0	0	0	0	0	0	0	0	0	0	0
16	5	0	0	5	2.5	0	0	0	5	1.25	1.9
17	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	5	1.25	5	5	0	0	2.5	1.9
19	5	5	0	20	7.5	5	0	5	15	2.5	5
20	0	0	5	10	3.8	5	0	0	0	1.25	2.5
21	0	0	0	20	5	5	5	5	5	5	5
22	35	30	10	10	21.6	15	25	0	15	13.8	16.2

	Right Ear					Left Ear					
Subject	.5K	1K	2K	4K	$\overline{X}$	.5K	1K	2K	4K	$\overline{X}$	R-L $\overline{X}$
23	25	25	0	0	12.5	10	15	0	0	6.3	9.3
24	15	10	15	5	11.3	10	10	10	5	8.8	10
25	50	45	20	35	37.5	35	35	20	20	27.5	32.5
26	15	5	10	0	7.5	5	5	5	5	5	6.9

$\Sigma \overline{X} = 167.75$ $\Sigma \overline{X} = 146.25$

$\Sigma \overline{X} = 151.69$

BONE CONDUCTION TESTING RESULTS
FOR THE EXPERIMENTAL GROUP*

	Right Ear				Left Ear			
Subject	.5K	1K	2K	4K	.5K	1K	2K	4K
2								0
7							0	0
8	5	10	5	10	15	15	5	10
10					0			
12								0
13	0	0	0	0	0	0	0	0
19				0				0
21				0				
22	5	5	5	0	5	10	5	10
23	0	0				10		
24	5		5			5	5	
25	5	10	5	10	5	0	10	10
26	0							

*If a 15 dB or more air conduction loss was evinced at any frequency, bone conduction testing was employed.

APPENDIX D

Pure Tone Air & Bond Conduction

Test Results for the Control Group

PURE TONE HEARING TESTING RESULTS
FOR THE CONTROL GROUP

	Right Ear					Left Ear					
Subject	.5K	1K	2K	4K	$\bar{X}$	.5K	1K	2K	4K	$\bar{X}$	R+L $\bar{X}$
1	0	0	5	0	1.25	0	0	0	5	1.25	1.3
2	10	0	5	15	7.5	5	20	15	15	13.8	10.6
3	10	10	0	0	5	5	15	0	15	8.8	6.7
4	45	50	45	30	42.5	10	0	10	15	8.8	25.6
5	5	5	5	5	5	5	0	15	5	6.3	5.6
6	0	0	0	0	0	20	10	0	5	8.8	4.3
7	5	0	0	0	1.25	5	5	0	5	3.8	2.5
8	0	10	0	10	5	5	20	0	15	10	15
9	0	0	0	0	0	5	0	0	5	2.5	1.25
10	5	5	0	0	2.5	5	0	0	0	1.25	1.9
11	0	0	0	45	11.3	0	0	0	10	2.5	6.9
12	0	0	0	5	1.25	0	0	0	15	3.8	2.5
13	0	0	0	65	16.3	0	10	0	35	8.8	12.5
14	0	0	0	0	0	0	0	0	10	2.5	1.3
15	20	5	25	10	15	20	0	5	25	12.5	13.8
16	5	0	5	10	5	5	0	0	5	2.5	3.8
17	0	0	45	35	20	0	5	0	5	2.5	11.3
18	5	0	10	15	7.5	0	0	10	5	3.8	5.6
19	0	0	0	10	2.5	5	5	0	30	10	6.3

	Right Ear					Left Ear					
Subject	.5K	1K	2K	4K	$\overline{X}$	.5K	1K	2K	4K	$\overline{X}$	R+L $\overline{X}$
20	0	0	35	20	13.8	5	0	25	20	12.5	13.8
21	15	15	5	5	10	10	10	15	10	8.8	9.4
22	10	5	5	5	6.3	15	5	0	25	11.3	8.8
23	10	5	15	10	10	5	0	0	0	1.25	5.6
24	15	15	5	5	10	10	5	10	15	10	10
25	10	5	15	15	11.3	15	15	5	15	12.5	23.8
26	5	0	0	0	1.25	5	0	0	0	1.25	1.25

$\Sigma\ \overline{X} = 195$

$\Sigma\ \overline{X} = 171.25$

$\Sigma\ \overline{X} = 210.21$

BONE CONDUCTION TESTING RESULTS
FOR THIS CONTROL GROUP*

	Right Ear				Left Ear			
Subject	.5K	1K	2K	4K	.5K	1K	2K	4K
2			5			0	0	0
3						5		5
4	5	5	5	0				0
5							0	
6					0			
8						5		5
11				0				
12								0
13				25				30
15	15	5	5		15			0
17			0	5				
18				10				
19								5
20			20	20			20	15
21	10	10						
22					0			10
23			0					
24	0	0						0
25			0	0	0	0		0

*If a 15 dB or more air conduction loss was evinced at any frequency, bone conduction testing was employed.

APPENDIX E

Reliability Data for the Experimental & Control Groups

RELIABILITY CHECK RESULTS ON
THE EXPERIMENTAL GROUP

	Right Ear				Left Ear			
Subject	.5K	1K	2K	4K	.5K	1K	2K	4K
1	0	0	0	0	0	0	5	0
2	0	0	0	0	0	0	0	15
3	0	0	0	0	0	0	0	0
4	0	0	0	5	0	0	0	0
5	5	0	0	0	0	0	5	0
6	0	0	0	10	0	0	0	10
7	0	0	0	0	0	5	0	0
8	25	15	20	25*	10	10	20	30
9	0	0	0	0	0	0	0	0
10	0	0	0	10	10	15	10*	10
11	10	0	0	0	5	0	0	5
12	0	0	0	0	0	0	5	15
13	35	10	25	25	20	10	0*	20
14	15	5	0	5	10	5	5	0
15	0	0	0	0	0	0	0	5
16	5	0	0	5	5	0	0	5
17	0	0	0	0	0	0	0	0

	Right Ear				Left Ear			
Subject	.5K	1K	2K	4K	.5K	1K	2K	4K
18	5	0	0	0	0	0	0	0
19	5	5	5	25	5	5	10	0
20	5	5	10	15	5	5	5	5
21	0	0	0	25	10	10	0	10
22	30	25	5	10	15	15*	0	5*
23	20	20	0	0	10	15	0	0
24	15	15	25*	5	15	15	10	5
25	55	50	20	35	35	35	20	20
26	10	5	5	5	10	5	5	15

*results between experimenters differ by more than ± 5 dB.

RELIABILITY CHECK RESULTS ON

THE CONTROL GROUP

	Right Ear				Left Ear			
Subject	.5K	1K	2K	4K	.5K	1K	2K	4K
1	0	0	10	0	0	0	0	5
2	10	0	0	15	5	20	20	15
3	0*	0*	0	0	10	10	0	15
4	45	50	45	35	10	0	10	15
5	5	5	5	5	5	0	15	5
6	0	0	0	0	20	10	0	10
7	10	5	0	5	10	0	0	0
8	10*	15	0	10	15*	20	5	10
9	0	0	0	0	0	0	0	5
10	5	5	0	0	0	0	0	0
11	0	0	0	45	0	0	0	15
12	0	0	0	10	0	0	0	15
13	0	0	0	70	0	10	0	30
14	0	0	0	5	0	5	5	10
15	15	5	25	10	20	10*	5	20
16	0	0	0	0	10	5	0	5
17	0	0	40	50	0	0	5	10

	Right Ear				Left Ear			
Subject	.5K	1K	2K	4K	.5K	1K	2K	4K
18	0	0	5	10	0	0	5	0
19	5	5	5	5	0	5	0	35
20	0	0	35	20	0	0	25	25
21	0*	0*	10	15*	0*	5	15	0*
22	15	5	0	5	10	5	5	20
23	10	5	5	0*	10	0	5	5
24	15	15	5	5	10	5	10	15
25	10	5	15	15	15	15	5	15
26	5	0	0	0	5	0	0	0

*results between the experimenters differ by more than ±5 dB